Agglomeration and regional employment growth

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Abstract

The advent of the New Economic Geography has spawned a renewed interest in questions of agglomeration. The present work expands the research on the impact of agglomeration economies on employment growth by connecting two strands of the empirical literature. A localization index and a cluster index are calculated in order to measure the prevalence of agglomeration. Using these indices, industries and locations that exhibit geographical concentration are identified. The main part of the paper is an econometric analysis. In a dynamic panel data model, the two indices are explicitly used to measure additional dynamic employment growth in agglomerated plants.

The study uses panel data that covers all western German employment subject to social security from 1989 to 2006 in 326 districts. I analyze which regional characteristics favor the growth of employment in 191 industries of the manufacturing and service sectors. There is evidence that industrial agglomerations exhibit stronger dynamic growth than other industry/region cells.

Zusammenfassung

Seit dem Aufkommen der Neuen Ökonomischen Geographie hat auch das Interesse an den Fragen der Agglomeration wieder zugenommen. Die vorliegende Arbeit erweitert die bestehenden Erkenntnisse über die Auswirkungen von Agglomerationsvorteilen auf das Beschäftigungswachstum, indem sie zwei unterschiedliche Zweige der empirischen Literatur vereint. Zunächst werden ein Lokalisationsmaß und ein Clusterindex berechnet, um die Verbreitung von geographischer Konzentration zu messen. Der Kern des Papiers ist eine ökonometrische Analyse. In einem dynamischen Panelmodell werden diese Indizes explizit genutzt, um das zusätzliche dynamische Beschäftigungswachstum in lokalisierten Wirtschaftszweigen zu messen.

Für die Schätzungen wird ein Paneldatensatz mit allen sozialversicherungspflichtig Beschäftigten in Westdeutschland in 326 Landkreisen und kreisfreien Städten über den Zeitraum 1989 bis 2006 verwendet. Anhand dieser Daten wird analysiert, welche regionalen Gegebenheiten das Beschäftigungswachstum in 191 Wirtschaftszweigen des verarbeitenden Gewerbes und des Dienstleistungssektors begünstigen. Die Ergebnisse deuten darauf hin, dass agglomerierte Branchen/Regions-Zellen ein besonders starkes dynamisches Wachstum aufweisen.

JEL classification: O47, R11, R12

Keywords: Employment Growth, MAR Externalities, Jacobs Externalities

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1 Introduction

As Krugman (1991) pointed out in his seminal book, the most striking feature of economic geography is agglomeration. In this context, agglomeration stands for “the clustering of economic activity, created and sustained by some sort of circular logic” (Fujita/Krugman/Venables, 1999).[1] A particularly interesting aspect of agglomeration is localization, the geographical concentration of firms of the same industry. The fact that many industries are more or less geographically concentrated offers first evidence for the existence of external economies of scale that motivate firms to seek the proximity of others. This poses the question how the regional industrial structure affects regional economies and their further development. To avoid confusion in the terminology, it is useful to do a quick delineation of the different terms of agglomeration. According to the description above, agglomeration is the generic term that can mean whole cities as well as business districts, highly specialized clusters and so forth. The terms localization and geographic concentration have a more narrow meaning. An industry is localized or geographically concentrated, when it is not evenly distributed over the whole area of a country. These two terms just refer to industries as a whole. Regions where a high number of establishments of localized or geographically concentrated industries are situated are called industrial agglomerations (cf. O’Donoghue/Gleave, 2004). Finally, clusters are “geographic concentrations of interconnected companies, specialized suppliers, service providers, firms in related industries, and associated institutions (e.g., universities, standards agencies, trade associations) in a particular field that compete but also cooperate” (Porter, 2000: p. 15).

For a long time, there has been a rising interest in how to measure agglomeration and its effects on regional economies, particularly on regional labor markets and employment growth. Early empirical studies purely described localization of industries (e.g., Hoover, 1936). Introducing the New Economic Geography, Krugman (1991) also simply calculates locational Gini coefficients. In this “very preliminary statistical work” (Krugman, 1991: pp. 55 ff.), he finds that most industries are localized. Several other studies resort to the Gini coefficient as well (cf. Litzenberger, 2006; Südekum, 2006). In their widely regarded article Ellison/Glaeser (1997) create a more sophisticated index (henceforth EG index) that has motivated a huge number of studies to measure industrial concentration in various countries, including the United States, France, England, Belgium, Germany, Australia and China.[2] Their results depend heavily on the level of regional aggregation chosen for the analysis.

The Gini and EG index only describe which industries are geographically concentrated. Consequently, they vary only between industries. They cannot provide answers to the question, in which regions the corresponding establishments are located. Newer contributions by both economists as well as geographers pursue this issue by developing and applying methods to identify clusters. A widely used measure is the location quotient (cf. O’Donoghue/Gleave, 2004). Litzenberger/Sternberg (2006) develop their own cluster index

[1] For an extensive explanation cf. Roos (2002).

[2] cf. Maurel/Sédillot (1999); Rosenthal/Strange (2001); Devereux/Griffith/Simpson (2004); Bertinelli/Decrop (2005); Alecke et al. (2006); Alecke/Untiedt (2008); Leahy/Palangkaraya/Yong (2007); Lu/Tao (2009).

based on the location quotient, while Brenner (2004, 2006) and Bottazzi et al. (2008) use density functions to compare empirical distributions of economic activity with theoretical ones. These measures allow the identification of regions that accommodate an exceptionally large number of establishments of an industry compared to an aggregate area. However, as most of these authors admit themselves, these measures are not adequate to describe clusters following Porter's (2000) definition. Using administrative data in a top-down approach i.e., trying to identify clusters out of a huge number of industry/region observations, it is hardly possible to uncover interrelations between establishments of different industry classes. To do this, case studies like CORIS[3] would be required. In the remainder of this paper, this should be kept in mind whenever the word cluster is used and the more accurate term industrial agglomeration is preferred whenever possible.

The above mentioned papers are descriptive in the sense that they study the existence of agglomeration. In this paper's context this is only the first step. The second step is to explore the effects caused by agglomeration and to analyze how they affect employment growth. However, there is no standard approach. Glaeser et al. (1992) and Henderson/Kuncoro/Turner (1995) analyze the effects of localization as well as diversification on employment growth. Using basically the same model, they obtain rather different results. While the first do not find localization effects, the latter favor these especially for older, well-established firms. Again using similar models, this discussion has been continued by numerous studies, which also arrive at varying conclusions.[4] These studies explicitly control for localization, mostly using location quotients, allowing for a straightforward inference on the (non-)existence of agglomeration effects on employment growth. Their major caveat is that they only use a cross-section approach: growth between two years is explained by conditions of the first year. While this avoids methodical problems, it is not possible to use fixed effects in order to control for unobservable heterogeneity between the observations. Other studies use panel data and analyze growth over a series of years.[5] This allows growth to be regarded as dynamic, which means that growth between two consecutive years can depend on previous growth. In a recent meta-analysis de Groot/Poot/Smit (2008) compare the findings of 31 studies in this field. They find that results heavily depend on the structure of the data and on how agglomeration is incorporated in the models.

This study contributes to the discussion on how to measure agglomeration effects and which kind of effects actually play a significant role. Extensive panel data on all German employees in the years of 1989 to 2006 is used to analyze the impact of agglomeration effects on dynamic employment growth. The unit of observation is the aggregate of all employees in a 3-digit industry in a NUTS-3 region. The main question is whether there are agglomeration externalities that foster long-term effects of initial employment growth. In a first step, geographically concentrated industries and the related regions are identified. Then this information is used in the following empirical analysis to allow the strength of dynamic employment growth to vary between agglomerated and non-agglomerated observations. The empirical evidence suggests that industrial agglomerations do indeed show

3 "ClusterOriented Regional Information System" `http://www.coris-online.de`

4 cf. Ó'hUallacháin/Sattertwhaite (1992); Combes (2000); Batisse (2002); Südekum (2005); Frenken/Oort/Verburg (2007); Mameli/Faggian/McCann (2008); Otto/Fornahl (2008).

5 cf. Henderson (1997); Combes/Magnac/Robin (2004); Blien/Südekum/Wolf (2006); Fuchs (2009)

stronger dynamic growth, while just the fact that a whole industry is localized does not significantly influence dynamic growth of this industry's employment in all regions.

The remainder of the paper is organized as follows. Section 2 calculates two indices and describes the prevalence of geographical concentration in Germany. The following section presents some theoretical thoughts on how this might affect employment growth. Section 4 discusses the estimation strategy of the econometric analysis that uses the indices from section 2, while section 5 explains the data set. The results of the analysis are discussed in section 6 and section 7 concludes.

2 Geographic Concentration of Industries in Germany

Before turning to the analysis of agglomeration effects, let us first take a look at some stylized facts of the geographic concentration of industries in Germany. Germany is organized as a decentralized federal republic, where the capital does not contain a major share of economic activity. Hence, we cannot assume a priori that there is a strong degree of localization in a certain region. A special case hereby is post-communist Eastern Germany. Since reunification in 1990, this part of the country has undergone specific developments which might have led to localization patterns, that are not necessarily due to agglomeration externalities.[6] Since these different effects cannot be disentangled, Eastern Germany is not considered at all in the following analysis. Regional information is available at the level of administrative districts (Landkreise und kreisfreie Städte - NUTS-3 regions). Since administrative districts do not coincide with functional regions, proximity of firms across regional borders cannot be taken into account.[7] An alternative regional level would be labor market regions (cf. Eckey/Schwengler/Türck, 2007) which are defined according to commuting flows. One could argue that externalities between these regions are less likely. However, with increasing size of the regions, their economic structure converges to that of the whole country. Thus, using a higher level of aggregation might also be risky, which speaks in favor of a more disaggregated level. While the literature on measurement of agglomeration favors higher aggregation (cf. Ellison/Glaeser, 1997; Alecke et al., 2006), studies on its effect on growth often use disaggregated regional data (cf. Combes/Magnac/Robin, 2004; Blien/Südekum/Wolf, 2006). Since this paper is primarily interested in the latter question, 326 NUTS-3 regions are used.[8] Choosing the level of sectoral aggregation poses a similar challenge. To take the characteristics of different industries into account, the highly disaggregated 3-digit WZ93 classification is used.[9]

[6] For example, public enterprises of the formerly socialist system were divestitured and privatized. This might lead to an increase of the indices calculated in this section that is not caused by agglomeration externalities. There have also been huge public subsidies for entrepreneurship or relocation of establishments offering pecuniary incentives to locate in Eastern Germany. Consequently, localization patterns might have been created not for economic reasons but rather for historic reasons or because of public intervention.

[7] Methods based on distances do not have this problem but require cartesian coordinates of each establishment. Respective indices had been developed by Marcon/Puech (2003) and Duranton/Overman (2005) and were applied to French and English industries, respectively.

[8] The robustness of the main results regarding this choice will be checked in section 6.2.

[9] Mameli/Faggian/McCann (2008) compare different aggregation levels and obtain results that also support highly disaggregated data. For lists of all German industry classifications, cf. `http://doku.iab.de/fdz/Klassifikationen_de_en.xls`

An intuitive measure for geographical concentration of an industry is

$$G = \sum_{r=1}^{N} (x_r - s_r)^2, \tag{1}$$

where x_r is region r's share of overall employment and s_r is region r's share of the respective industry's aggregate employment. G shows how the geographic distribution of an industry's employment differs from the geographic distribution of overall employment. Like the Gini coefficient, G takes a value of zero if both distributions are identical and a value of one if an industry is localized in only one region. Ellison/Glaeser (1997) criticize that G is not adequate to measure geographical concentration that did not evolve by coincidence but rather because of benefiting from agglomeration externalities. The latter would not lead to a deviation from a uniform distribution but rather from a random distribution that takes the number of regions and size of establishments into account.[10] They extend the index G from equation 1 with the industry structure:

$$EG = \frac{G - (1 - \sum\limits_{r=1}^{N} x_r^2)H}{(1 - \sum\limits_{r=1}^{N} x_r^2)(1 - H)}, \tag{2}$$

where H is the industry's Herfindahl index $H = \sum_{j=1}^{B} z_j^2$, with z_j the firm j's share of the industry's employment. This index is deduced from a theoretical model of site selection, where two different forces lead to agglomeration: spillovers and natural resources. Although it cannot disentangle these forces, the EG index is widely used in the literature to analyze the causes of agglomeration.[11] Many of these studies show that especially industries that require a lot of resources tend to localize. Despite its favorable features and the number of studies using this index, the EG is still far from being standard since its computation requires comprehensive firm-level data on employment. Since the EG does not allow for hypothesis testing, Ellison/Glaeser (1997) suggest to step back to the raw index G, which has an expected value of $E(G) = (1 - \sum_{r=1}^{N} x_r^2)H$ in absence of agglomeration effects. If the empirical value of G exceeds $E(G)$ by two standard deviations, an industry can be regarded to be concentrated significantly stronger than what would be expected by a random distribution ("2-sigma-rule").[12] Regarding the magnitude of their results, Ellison/Glaeser (1997) propose that a value higher than 0.02 should be regarded as an indication that the industry is substantially geographically concentrated, while a value above 0.05 even indicates strong concentration. Although these thresholds seem to be rather arbitrary, they have been used in the majority of studies calculating the EG index.

[10] They visualize the difference between a uniform and a random distribution of firms with a "dartboard approach": if you throw ten darts randomly at a map with nine regions, you will inevitably observe concentration in at least one region.

[11] cf. Maurel/Sédillot (1999); Rosenthal/Strange (2001); Bertinelli/Decrop (2005); Alecke et al. (2006); Alecke/Untiedt (2008).

[12] According to the authors, the variance of G can be calculated as
$\sigma_G^2 = 2\left\{H^2\left[\sum_{r=1}^{N} x_r^2 - 2\sum_{r=1}^{N} x_r^3 + (\sum_{r=1}^{N} x_r^2)^2\right] - \sum_{j=1}^{B} z_j^4\left[\sum_{r=1}^{N} x_r^2 - 4\sum_{r=1}^{N} x_r^3 + 3(\sum_{r=1}^{N} x_r^2)^2\right]\right\}$.
Note that country and industry specific terms enter both the expected value and the variance of G (cf. Vitali/Napoletano/Fagiolo, 2009).

The following descriptive analysis presents results of the EG index for the year 2006. For agriculture, mining, and the public sector no EG index is calculated. The first two sectors are geographically concentrated just because it is dictated by the need for natural resources and not because of localization economies.[13] Localization decisions for the public sector are probably based on other than economic reasons. 101 of the 191 remaining industries are significantly localized according to the "2-sigma-rule". This equates to more than half of all observed industries and confirms Krugman's (1991) observation that localization is more the norm than an exception. However, turning to the magnitude of geographical concentration, we measure a mean EG of 0.0052. Only 21 industries exceed the value of 0.02, while 7 industries have an EG larger than 0.05. Thus, most German industries seem to be localized, but not very strongly.[14] Table 1 shows the 21 industries with EG-values larger than 0.02. While there are some high tech industries with high values of the index, we find many industries that have to make their location decisions according to geographical aspects like proximity to coasts or transportation routes. However, there are also manufacturing and service industries which would not have been expected to be geographically concentrated at first thought.

Table 1: Geographically concentrated industries 2006

EG	Industry code WZ93	
0.1330	611	Sea and coastal water transport
0.0869	152	Processing and preserving of fish and fish products
0.0857	263	Manufacture of ceramic tiles and flags
0.0747	335	Manufacture of watches and clocks
0.0716	671	Activities auxiliary to financial intermediation
0.0639	362	Manufacture of jewellery and related articles
0.0552	652	Other financial intermediation
0.0489	921	Motion picture and video activities
0.0448	622	Non-scheduled air transport
0.0431	176	Manufacture of knitted and crocheted fabrics
0.0410	732	Research and experimental development an social sciences and humanities
0.0385	632	Other supporting transport activities
0.0355	334	Manufacture of optical instruments and photographic equipment
0.0350	924	News agency activities
0.0349	172	Textile weaving
0.0340	262	Manufacture of non-refractory ceramic goods other than for construction purposes
0.0263	660	Insurance and pension funding, except compulsory social security
0.0257	351	Building and repairing of ships and boats
0.0251	300	Manufacture of office machinery and computers
0.0249	612	Inland water transport
0.0204	202	Manufacture of veneer sheets, plywood and other panels and boards

Source: IAB Establishment History Panel, own calculations

While the EG-Index presents evidence on geographical concentration, it can only vary between industries. It is not possible to determine which regions accommodate highly concentrated industries. To add this regional dimension, measures specifically designed to identify clusters can be applied. They all use a top-down approach, i.e., they do not analyze the features of single clusters but rather compare a multitude of regions and industries

[13] Mining of uranium ore for example is the most concentrated industry in Germany, simply because there is only one county featuring an uranium deposit.

[14] This is in line with the findings of other studies using the EG. Deviations from the results of Alecke et al. (2006) stem from different years of observation and the use of full-time equivalents instead of the total number of employees as a measure for employment in this study. Since they restrict their analysis to the manufacturing sector, it is not surprising that they find a higher share of localized industries (78 percent).

in order to identify some of them as clusters. Since they have to rely on administrative industrial classifications like WZ93, NACE,[15] or ISIC[16] they fail to detect proximity of interrelated establishments from different industries. Hence, an important feature of clusters as defined by Porter (2000), the interaction of establishments from different sectors like manufacturing and services, cannot be considered. Thus, these approaches are not able to identify clusters in their narrow meaning. Still, these measures are able to identify industrial agglomerations as regions that accommodate noticeably more employment of a localized industry than the aggregate of all regions. Thus, they are used here to add a regional dimension to the above mentioned localization indices.

Basically the location quotient $LQ_{ir} = \frac{e_{ir}/e_r}{e_i/e}$, that relates the share of employment in region r and industry i in total employment in region r to the share of total employment in industry i in total employment in the whole country (cf. O'Donoghue/Gleave, 2004), would be sufficient to uncover industrial agglomerations. Litzenberger/Sternberg (2006) develop the "Cluster Index" CI that is based on the LQ,[17] but extents it by some features:

$$CI_{ir} = \frac{\frac{e_{ir}}{a_r}}{\frac{\sum_{r=1}^{N} e_{ir}}{\sum_{r=1}^{N} a_r}} \times \frac{\frac{e_{ir}}{z_r}}{\frac{\sum_{r=1}^{N} e_{ir}}{\sum_{r=1}^{N} z_r}} \div \frac{\frac{e_{ir}}{b_{ir}}}{\frac{\sum_{r=1}^{N} e_{ir}}{\sum_{r=1}^{N} b_{ir}}} = \frac{\frac{e_{ir}}{\sum_{r=1}^{N} e_{ir}}}{\frac{z_r}{\sum_{r=1}^{N} z_r}} \times \frac{\frac{b_{ir}}{\sum_{r=1}^{N} b_{ir}}}{\frac{a_r}{\sum_{r=1}^{N} a_r}}, \tag{3}$$

where e is employment, a surface area, z population and b the number of establishments, while i and r denote industry and region, respectively. The index can be decomposed in three parts (the three ratios in the first equation), which establish several (but not all) conditions of regional clusters: A region has to feature a higher density of employment in a certain industry with regard to area and population, compared to the aggregate country. Since the first two ratios can be high in the presence of one single huge establishment, this effect is controlled for by dividing through the ratio of the mean establishment size in the cell to the one in the whole industry. Due to the multiplicative relation, the CI takes a value of one if the structure of the industry/region cell equals the one of the whole country. CI values that exceed the value of 64 are designated as clusters. This threshold is chosen rather arbitrarily by Litzenberger and Sternberg as the point where all three ratios are four times as high as in the aggregate country ($CI = 4^3 = 64$). This threshold is also used in the present study to identify an observation as an industrial agglomeration.

Table 2 contains the industry/region cells with the highest CI-values in the year 2006.[18]

[15] Nomenclature statistique des activités économiques dans la Communauté européenne (Statistical classification of economic activities in the European Community).

[16] International Standard Industrial Classification of all Economic Activities.

[17] This is the case when the share of population in region i in the total population equals the share of the labor force in region i in the total labor force. This holds true at least by approximation.

[18] At first sight, including miscellaneous manufacturing n.e.c. might seem odd. However, one has to consider that this is a residual industry only on the 3-digit level. In the case of Kaufbeuren, there is indeed a large number of small establishments producing imitation jewelery.

Table 2: The 20 industry/region cells with the highest CI values in 2006

CI	District	Industry code WZ93
361699	Bottrop, Stadt	Manufacture of coke oven products
167291	Bremerhaven, Stadt	Processing and preserving of fish and fish products
87691	Pirmasens, Stadt	Manufacture of footwear
61844	Pforzheim, Stadt	Manufacture of watches and clocks
39305	Pforzheim, Stadt	Manufacture of jewellery and related articles
27852	Frankfurt am Main, Stadt	Scheduled air transport
24977	Duisburg, Stadt	Manufacture of coke oven products
24927	Merzig-Wadern	Manufacture of ceramic tiles and flags
24779	Trier, Stadt	Manufacture of tobacco products
22701	Peine	Processing of nuclear fuel
19722	Bayreuth, Stadt	Manufacture of tobacco products
11449	Straubing, Stadt	Manufacture of sports goods
10856	Kaufbeuren, Stadt	Miscellaneous manufacturing n.e.c.
9539	Remscheid, Stadt	Manufacture of cutlery, tools and general hardware
9446	Emden, Stadt	Transport via pipelines
8930	Solingen, Stadt	Manufacture of cutlery, tools and general hardware
8904	Zollernalbkreis	Manufacture of knitted and crocheted fabrics
8714	Kassel, Stadt	Manufacture of railway and tramway locomotives and rolling stock
8532	Wilhelmshaven, Stadt	Transport via pipelines
8145	Emden, Stadt	Building and repairing of ships and boats

Source: IAB Establishment History Panel, own calculations

Many industries that have high EG values can be recognized. To summarize the findings, we note that the mean CI is 38.80 with a median of 1.11. 3.40 percent of all cells show CI values larger than 64. Compared to the previous finding that more than 50 percent of all industries are geographically concentrated, industrial agglomeration seems to be restricted to a relatively small number of observations, which is consistent with the intuition. In order get a picture of the geographical distribution of industrial clusters, figure A.1 in the appendix shows the numbers of industries with CI values larger than 64 in each region. On the one hand, many rural areas house only very few industrial agglomerations or even none at all. On the other hand, higher numbers of industrial agglomerations are located only in cities. This might be due to the way of calculating the CI: It is more difficult for industries to attain high CI values in large, sparsely populated regions. Still, it is obvious that industrial agglomerations are not isolated but rather co-exist with others of different industries. When agglomeration effects are analyzed later on, this fact should be kept in mind.

These findings give a first quantitative impression of the prevalence of geographical concentration and where it is located. We can summarize that localization is a very common phenomenon in Germany and concerns more than half of all industries in the manufacturing and service sector. However, most of this concentration is rather weak and only a small fraction of all observations is substantially concentrated. The remainder of this paper is dedicated to the question whether these localized industries or industrial agglomerations still exhibit stronger employment growth than other observations. Although not presented in this section, both indices, EG and CI, are calculated for each of the years 1989 to 2006 and will be used in the econometric analysis in section 6 to allow for different growth patterns of concentrated and dispersed observations. Before turning to an analysis of the growth effects in the respective regions, some theoretical implications of agglomeration externalities will be described.

3 Theories on Agglomeration Effects

Since the early 1990s, the New Economic Geography (cf. Krugman, 1991, Fujita/Krugman/Venables, 1999) has attracted much attention to regional questions, especially to cumulative processes leading to agglomeration. Of course, the question why economic activity is not evenly distributed across space, is much older (cf. von Thünen, 1826; Hotelling, 1929; Christaller, 1933; Lösch, 1940). In the context of economic growth theory there has also been interest in the fact that economic subjects can benefit from each others' mutual proximity (cf. Arrow, 1962a; Romer, 1990). Thus, a favorable economic environment can have positive effects on productivity and on employment growth. Agglomerative forces cause external economies of scale, from which, as opposed to internal economies of scale, every subject in a region can benefit (cf. Scitovsky, 1954; Fujita/Thisse, 1996). Especially firms that are in some way related can benefit from each other's proximity. The consequence would then be the evolution of clusters like Silicon Valley or Detroit (cf. Fujita/Mori, 2005).

When analyzing agglomeration effects, one should distinguish between exogenous and endogenous factors. Exogenous factors like natural resources or the geographic location can explain the historical distribution of establishments. In the present research they play a minor role, since they are not able to explain further growth of already geographically concentrated industries (cf. Roos, 2005). Endogenous factors on the other hand are self-reinforcing effects that depend on the number and sector of establishments in a given region. They are dynamic which means that they underlie a circular logic. Agglomeration leads to positive external effects which increase productivity and attracts more employment which in turn leads to further agglomeration.[19] Among these dynamic endogenous factors, the literature distinguishes between so called Jacobs- (after Jacobs, 1970) and MAR externalities (after Marshall, 1920; Arrow, 1962b; Romer, 1986), (cf. Henderson, 1997).[20] Both externalities explain how agglomeration causes positive effects on productivity and employment growth.[21] They differ in the specific form of agglomeration that has to exist for them to become effective. Jacobs externalities are positive external effects in cities that are caused by many diversified employees, establishments and institutions that benefit from their mutual proximity. By contrast, MAR externalities arise through the proximity of many establishments of the same industry which allows them to benefit from specialization (cf. Krugman, 1991, Fujita/Thisse, 1996).

Since Jacobs externalities depend on a diversified urban economic structure, it is most likely that they occur in regions that do not specialize in only a small number of industries. Jacobs (1970) calls an overly monotonous urban structure the "attributes of stagnant settlements". Economic growth rather depends on the creation of "new work", which benefits

[19] In theoretical models, a "no black hole condition" prevents this self enforcing process to become excessively strong (cf. Fujita/Krugman/Venables, 1999).

[20] There are also urbanization and localization externalities. While they are sometimes used synonymously, these are in fact the respective static counterparts to Jacobs and MAR externalities (cf. Partridge/Rickman, 1999).

[21] Of course a rise in productivity does not necessarily induce employment growth (cf. e.g. Appelbaum/Schettkat, 1995). However, since regionally representative data on productivity is very rare, many studies focus on employment growth instead.

from a diversified environment.[22] Intermediate inputs, business related services and the general infrastructure are best available in bigger cities. A further issue is the quality of life in cities. At the price of unfavorable aspects like air pollution, crime, traffic, et cetera, diversified cities offer e.g. a good infrastructure, recreational facilities, or nightlife. This is particularly attractive to very creative people (Florida's (2004) "creative class"). They are characterized by a higher income compared to the remaining population, professional success and the capability to realize their ideas. In order to recruit this kind of workers, companies have to advertise with attractive locations because they value good living conditions higher than pecuniary success. These creative people could inspire each other such that innovations and other externalities evolve in diversified cities (cf. Feldman/Audretsch, 1999). Through the innovative environment and the presence of a highly productive workforce, Jacobs externalities increase productivity in agglomerations and cause circular effects that ultimately can stimulate dynamic employment growth. For these mechanisms to work, a region does not necessarily need to accommodate one or more geographically concentrated industries but rather a preferably diversified mix of industries.

MAR externalities arise out of the proximity of a high number of related establishments, i.e. firms of the same industry. This proximity leads to a reduction of transport costs. As the models of the New Economic Geography show, reducing costs of shipping merchandise between up- and downstream producers can provide an incentive for establishments to co-locate. Additionally, there are specialized suppliers and an already existing well adapted infrastructure. Specialized services like accountants, attorneys or advertising agencies may also be more readily available in industrial agglomerations (cf. Quigley, 1998). However, the reduction of transport costs is not restricted to commodities. It also applies to people and ideas. The first can be explained by a highly specialized labor supply in corresponding regions. Search costs for qualified personnel are reduced and there is a higher probability of successful matches. Qualified specialized workers from elsewhere have the incentive to move to such regions because of better job and wage opportunities. Proximity also promotes the spillover of knowledge and technologies between establishments. This could happen trough formal as well as informal channels (cf. Cohen/Paul, 2005; Henderson, 2007). While modern technology provides easy and inexpensive ways for the global transmission of information, this does not necessarily apply to knowledge and ideas. In this context, von Hippel (1994) refers to "sticky information", which needs strong effort to be transferred between individuals and across space. It is actually highly plausible that especially the transmission of knowledge and ideas requires personal contact between the involved actors. A productive cooperation between scientists for example is hardly imaginable if they have not met in person at least once. Since the possibility of these spillovers decreases with increasing distance between subjects (cf. Grilliches, 1979; Jaffe/Trajtenberg/Henderson, 1993), the proximity of establishments in the same region offers an especially beneficial environment. These effects are subsumed as the so-called three "Marshallian forces": (i) forward-backward linkages, (ii) labor market pooling and (iii) knowledge spillovers. It is not relevant whether geographic concentration of establishments of the same industry occurs in densely populated or rather rural regions. The

[22] For an extensive overview of older studies about urban diversity and economic growth, cf. Quigley (1998).

proximity of these establishments alone accounts for positive externalities and is able to stimulate employment growth. Even a few establishments of the same industry could create MAR externalities. In an industrial agglomeration, i.e., a region where an industry is concentrated, these effects should be particularly strong.

In the presence of Jacobs externalities, a diversified regional economic structure should promote employment growth. MAR externalities take place in geographically concentrated industries which should then exhibit dynamic employment growth. This means that employment growth in the past reinforces agglomeration economies causing a circular process which will enhance further growth. It has been stressed that both kinds of externalities can be effective separately. Yet, this does in no sense mean that they would be mutually exclusive. Figure A.1 clearly shows that many industrial agglomerations apparently are located within big cities. Thus, both externalities can very well be at work simultaneously. To measure their actual importance, the following propositions are tested empirically:

Proposition 1 *A diversified urban environment has a positive effect on employment growth.*

Proposition 2 *Industries that tend to concentrate geographically should exhibit stronger dynamic employment growth as a whole compared to other industries.*

Proposition 3 *In industrial agglomerations, as regions that feature a high share of one industry's employees, dynamic employment growth should be particularly strong.*

4 Estimation Strategy and Variables

This paper's aim is to study if and how the previously described Jacobs and MAR externalities increase regional employment growth. The observation cell is the aggregate number of employees in industry $i(i = 1 \ldots N)$ that is located in region $r(r = 1 \ldots R)$. The approach used by Blien/Südekum/Wolf (2006) and in parts also by Combes/Magnac/ Robin (2004) serves as a starting point. Basically, log employment $\ln e_{irt}$ is regressed on its own value at time $t-1$ and on control variables:

$$\begin{aligned}\ln e_{irt} &= \beta_0 + \alpha \ln e_{irt-1} + \beta_1 \ln sect_{irt} + \beta_2 \ln size_{irt} + \beta_3 div_{irt} \\ &\quad + \beta_4 \ln firmsize_{irt} + \beta_5 \ln education_{irt} + \beta_6 \ln wagelevel_{rt} + d_t + c_{ir} + u_{irt},\end{aligned} \tag{4}$$

where e_{irt} is employment in region r in industry i at time t, $sect$ the aggregate industry i employment in Western Germany, $size$ the aggregate employment in the region, div the degree of diversity in region r, $firmsize$ the share of employment in firms with less than 20 employees and $wagelevel$ the wage level in region r. d_t is a general time effect that controls for shocks that affect the economy as a whole like the business cycle and are thus not connected to agglomeration effects. c_{ir} is a time invariant fixed effect for every industry/region cell which captures unobserved location attributes like resource endowments, culture, geographical location or historical developments. The control variables are built as follows (cf. Blien/Südekum/Wolf, 2006):

- Sector effects:
$$sect_{irt} = \sum_{r'}^{R} e_{ir't} - e_{irt} \tag{5}$$
This controls for growth impulses that take effect on the whole industry in the whole country. To avoid endogeneity, the employment in the own cell is subtracted.

- Regional size:
$$size_{irt} = \sum_{i'}^{N} e_{i'rt} - e_{irt} \tag{6}$$
There can also be shocks that affect the whole region, which have to be controlled for. Again, own employment is subtracted to avoid endogeneity.

- Diversity:
$$div_{irt} = - \sum_{i'=1, i' \neq i}^{N} \left| \frac{e_{i'rt}}{e_{rt}} - \frac{e_{i't}}{e_t} \right| \tag{7}$$
This is the standard Krugman-diversification Index. It actually is a measure of the absence of diversification in region r multiplied by -1. If the local economic structure exactly equals the one of the whole country it takes a maximum value of zero. Its value becomes more negative, the more specialized a region is. This variable is intended to measure Jacobs externalities.

- Firm size:
$$firmsize_{irt} = e[in\ firms < 20\ employees]_{irt}/e_{irt} \tag{8}$$
The share of employees in small firms controls for the effect of internal economies of scale which could favor growth in larger firms (cf. Combes, 2000). On the other hand, McCann (2001) argues that innovation mainly takes place in clusters of small rather than large firms.

- Education:
$$education_{irt} = e[highly\ qualified]_{irt}/e_{irt} \tag{9}$$
Since innovation and entrepreneurship are highly interrelated with human capital, the education of the workforce plays an important role for employment growth. Education is captured by the share of employees with university and technical college degrees. Since both MAR- and Jacobs externalities rely on knowledge spillovers, the share of highly educated employees should have a strong impact on employment growth, especially in the presence of these externalities.

- Regional wage level:
To control for the level of wages paid in the region just using mean or median wages seems not to be adequate, since this variable would capture additional effects like productivity differences due to qualification or firm size structures. Instead, following Südekum/Blien (2004) and Blien/Südekum/Wolf (2006), an auxiliary wage regression on establishment level is used to calculate a “neutralized” wage level. For each year separately, the log median wages are regressed on establishment characteristics (size, size squared, proportions of young, male and highly qualified employees) and

dummy variables for regions and industries, respectively. The model is estimated under the constraint that the coefficients of the region dummies, weighted by the regions' shares in total employment, must sum up to zero. This normalization does not change the other coefficients but simplifies the interpretation of the dummy variables: a region with a coefficient significantly greater (smaller) than zero is a "high-wage" ("low-wage") region. These coefficients are used as control variables for the wage level in the main regression.

The inclusion of the lagged dependent variable $\ln e_{irt-1}$ is necessary to allow for an adjustment process and thus dynamic externalities to be effective. Since this term is correlated with the error term in the fixed-effects model, its coefficient is biased towards zero (cf. Nickell, 1981). To solve this problem, a first difference panel approach is used. This has two advantages. Firstly, following Anderson/Hsiao (1982) and Arellano/Bond (1991), it offers internal instruments. The first differenced lagged dependent variable $\ln e_{irt-1} - \ln e_{irt-2}$, which is correlated with the first differenced error term $u_{irt} - u_{irt-1}$, can be instrumented by further lags of the level values of the dependent variable. Secondly, subtracting the natural log of employment at time $t-1$ in cell ir from the log employment at time t in the same cell, i.e., $\ln e_{irt} - \ln e_{irt-1}$ is a good approximation of the growth rate of employment between these years. Fixed effects are still controlled for, since they are eliminated by differentiation. This model allows a straightforward interpretation of the coefficients as effects on the employment growth rate. However, it has to be kept in mind that all regressors are now measured in differences as well. Thus, the effects of stock values on growth cannot be determined. Equation 10 displays the model in first differences:

$$\begin{aligned}\ln e_{irt} - \ln e_{irt-1} = {} & \alpha(\ln e_{irt-1} - \ln e_{irt-2}) \\ & + \beta_1(\ln sect_{irt} - \ln sect_{irt-1}) + \beta_2(\ln size_{irt} - \ln size_{irt-1}) \\ & + \beta_3(div_{irt} - div_{irt-1}) + \beta_4\ (\ln firmsize_{irt} - \ln firmsize_{irt-1}) \\ & + \beta_5(\ln education_{irt} - \ln education_{irt-1}) + \beta_6(wagelevel_{irt} - wagelevel_{rt-1}) \\ & + \Delta d_t + u_{irt} - u_{irt-1}\end{aligned} \tag{10}$$

Holding everything else constant, Combes/Magnac/Robin (2004) and Blien/Südekum/Wolf (2006) claim that a very large coefficient of the lagged dependent variable (i.e., one or larger than one) can be interpreted as evidence for MAR externalities. Only then, employment would follow an explosive growth path, as the theory predicts.[23] On the other hand, an estimated coefficient considerably smaller than one (but greater than zero) would imply "mean reversion", which indicates convergence in the long run. This is what can be expected for the majority of all observations in the dataset, since they cannot benefit from MAR-type agglomeration economies (remember that only a small share of observations features substantial concentration, cf. section 2). Blien/Südekum/Wolf (2006) try to take this into account by conducting their analysis separately for 15 industries of manufacturing and six industries of the advanced service sectors. However, this does not seem to be de-

[23] However, in this case the autoregressive process would be non-stationary and neither of the prevalent estimation methods would lead to sensible results. Thus, this finding is never likely to occur.

tailed enough to allow for the differences between localized and dispersed industries. The more different industries are combined into one aggregate, the higher is the likelihood that the aggregates' firm distribution equals the one of the whole economy. Thus, the chances of really being able to observe localized industries decreases.

The crucial drawback of this specification is that it restricts the autoregressive parameter to be equal over all observations. If MAR externalities actually exist, they still should not be effective for observations that feature no kind of concentration. To overcome these shortcomings, a more detailed industrial classification is used and interaction effects are included to explicitly allow for different growth paths. Therefore, equation 10 is extended by the term $\lambda_{irt-1}(\ln e_{irt-1} - \ln e_{irt-2})$ where λ_{irt} is an indicator for geographic concentration. Although λ_{irt} could directly take the values of the indices presented in section 2, a binary variable is created for ease of interpretation. It takes the value of one if an observation is geographically concentrated according to the EG or CI, respectively.

$$\begin{aligned}\ln e_{irt} - \ln e_{irt-1} = {} & \alpha_1(\ln e_{irt-1} - \ln e_{irt-2}) + \alpha_2\lambda_{irt-1}(\ln e_{irt-1} - \ln e_{irt-2}) \\ & + \beta_1(\ln sect_{irt} - \ln sect_{irt-1}) + \beta_2(\ln size_{irt} - \ln size_{irt-1}) \\ & + \beta_3(div_{irt} - div_{irt-1}) + \beta_4\ (\ln firmsize_{irt} - \ln firmsize_{irt-1}) \\ & + \beta_5(\ln education_{irt} - \ln education_{irt-1}) + \beta_6(wagelevel_{irt} - wagelevel_{rt-1}) \\ & + \Delta d_t + u_{irt} - u_{irt-1}\end{aligned} \tag{11}$$

This allows the effect of previous growth to be of different magnitude depending on wether an observation is localized or not. Thus, the presence of MAR externalities can be tested directly, which was not possible in the former specification of equation 10. If the coefficient of the interaction term α_2 is significantly greater than zero, this presents evidence that in geographically concentrated industries, former growth is more conducive to further growth than in dispersed industries. Adding the two coefficients α_1 and α_2 gives the joint effect for dynamic growth in localized cells.

Equation 11 can be estimated using the Generalized Method of Moments. Aside from the lagged dependent variable, the interaction term is also correlated with the error term and has to be instrumented by lagged values as well. The main requirement for the instruments to be valid is that there is no higher order autocorrelation in the first differenced error term. $u_{irt} - u_{irt-1}$ follows an MA(1) process by construction, but serial correlation at order two or higher indicates that the moment conditions are not valid. A further problem of the Arrelano/Bond-estimator can occur when the autoregressive process is almost non-stationary, i.e., when the coefficient of the lagged dependent variable is close to unity. This can also be expected to happen in this context, at least for observations with $\lambda_{irt-1} = 1$. Blundell/Bond (1998) solve this problem by implementing further lags of the first-differenced lagged dependent variable as additional instruments and using a system of two equations, one in differences and one in levels. This approach will also be used in the following empirical analysis.

5 Data

The following analysis uses data from the Establishment History Panel (BHP) of the Research Data Center of the Federal Employment Agency at the Institute for Employment Research (IAB).[24] The origin of the BHP are mandatory social security notifications. German employers are obliged by law to report entries and exits of their employees subject to social security. The IAB stores this information in the Employee and Benefit Recipient History (BLH). A cross section of the BHP contains each establishment with at least one employee on June 30th of a given year. Data at the establishment level are generated by aggregation of personnel data from the BLH. The BHP covers almost the entire population of establishments. Exceptions mostly consist of self-employed which are not liable to social security. Unambiguous identification variables allow the cross sections to be combined to a panel data set. Employment levels in each cell are measured in full time equivalents. The BLH only discriminates between full time (39 or more hours per week), minor (less than 18 hours) and major part time (18 to less than 39 hours). Thus, the number of each kind of part time employees is multiplied with $16/39$ and $24/39$, respectively (cf. Ludsteck, 2006: p. 275).

Aside from its extend, the BHP has some advantages compared to survey data. Since notification is mandatory, there is no non-response. Due to its original use by the social insurances, the data is highly reliable. Of course, this origin also has disadvantages. Variables are restricted to those used by social insurance. Other interesting characteristics such as productivity or the establishments' technical state of the inventory are not included. Other variables include industry, location, median wage, and number of employees separated by gender, qualification, employment status, working hours, and age.

In this study, data from 1989 to 2006 is used. This raises problems due to a break in the official classification of industries. German administrative data sets use industry codes created by the Federal Statistical Office called WZ (for "Klassifikation der Wirtschaftszweige"). There are several versions, introduced in 1973 (WZ73), 1999 (WZ93), and 2003 (WZ2003). While changes between the latter two classifications were minor and can easily be harmonized, there was a huge break between WZ73 and WZ93. Even though there has been a transitional period from 1999 to 2002, it is very difficult to recode observations from the older to the newer one. Yet this is indispensable for this work, since WZ73 is not adequate for analyzing agglomeration externalities. First, there is no high tech or computer industry in WZ73, which might be particularly prone to concentrate geographically.[25] Moreover, this classification often fails to distinguish between manufacturing and trade. Hence, class 280 (manufacturing of automobiles and motors) covers car makers as well as local car dealers.[26] This disperses the observed distribution of the involved industries, which makes the identification of localization hardly feasible. To increase the period of observation to the years before 1999, the WZ93 industry codes of establishments that were observed during

[24] For detailed information on the BHP cf. Spengler (2008).

[25] Software development, for example, is hidden within class 770: publishing of books, newspapers and magazines.

[26] Another example is 351 (manufacturing of optical products) which contains both lens producers and opticians.

the transitional period are used for the whole time span from 1989 on. The industry of establishments that have closed before 1999 have to be estimated. In each region separately, for each industry class of the WZ73, that of WZ93 where most employees switched to when WZ73 was abolished is taken as replacement. This of course can cause some problems. First, establishments can change their sector. Second, the estimation of the industry is not completely accurate. Still, regarding the problems of the WZ73, this seems to be a reasonable "second-best" solution.

The data set was aggregated to the level of administrative districts (Landkreise und kreisfreie Städte - NUTS-3 Regions, comparable to counties) and three digit industry classes. Eastern German Regions are deleted from the data set for reasons explained section 2.

6 Results

6.1 Baseline Results

Using the previously described data on all employees subject to social security in manufacturing and service industries for the years 1989 to 2006, equation 11 is estimated using the Blundell/Bond (1998) system estimator. In order to allow the interpretation of long run effects, for each differentiated term of the lagged dependent variable and the interaction term, another lagged difference is added. For the differences of the control variables, two lags are added as well.[27] The endogenous regressors are instrumented by one additional lag of their first differences and levels respectively. The interaction term is built by multiplying the log employment level $\ln e_{irt}$ with a dummy variable λ that takes the value of one if the observation has an EG index of larger than 0.02 or a CI index of larger than 64.[28] For each of the two indices, the model is estimated separately.

Table 3 shows the structural regression estimates of the two models where dynamic growth is allowed to vary between geographically concentrated and dispersed industries and between industrial agglomerations and ordinary industry/region cells, respectively. The extremely large Sargan statistic is somewhat disturbing. It rejects the null hypothesis that the instruments are valid. However, Combes/Magnac/Robin (2004) and Blien/Südekum/Wolf (2006) had no such problems despite using the same instruments and the latter study even using the same data. The only major difference is the number of observations. Due to the much smaller level of aggregation, the number of observations in the present study is about ten times higher. This might cause the Sargan test to overreject (cf. Andersen/Sørensen, 1996; Hansen/Heaton/Yaron, 1996). Interestingly, when the size of the data set is reduced by randomly deleting groups, the null is no longer rejected. Moreover, the Arellano-Bond test for zero autocorrelation in first-differenced errors does not indicate higher-order autocorrelation. Thus, the main requirement for the moment conditions to be valid is fulfilled.

[27] Models with three and four lags have been estimated too. However, neither the contemporaneous effects nor the long term effects changed substantially. Thus, the parsimonious version with two lags is used. This also allows to use the rather small number of available periods most efficiently.

[28] Another possibility would have been to let λ take a value of one if an industry is significantly localized according to the "2-sigma-rule". Since this is the case for the majority of industries without localization being particularly strong, the higher threshold of 0.02 is chosen.

Table 3: Results dynamic panel data system estimation

Dependent Variable: ln employment		Model 1		Model 2	
		coeff.	z-Value	coeff.	z-Value
ln e					
	t-1	0.769***	115.44	0.745***	89.74
	t-2	0.026***	7.80	0.028***	6.73
ln e * EG					
	t-1	0.001	0.08	—	
	t-2	0.002	0.31	—	
ln e * CI					
	t-1	—		0.092***	3.37
	t-2	—		−0.050**	−2.07
ln sect					
	t	0.904***	38.72	0.915***	38.75
	t-1	−0.770***	−29.32	−0.742***	−27.88
	t-2	0.034***	2.56	0.031**	2.32
ln size					
	t	0.063**	2.04	0.045	1.45
	t-1	−0.049*	−1.74	−0.046	−1.63
	t-2	0.093***	3.48	0.076***	2.86
diversity					
	t	0.395***	9.71	0.379***	9.31
	t-1	−0.270***	−6.78	−0.276***	−6.86
	t-2	0.056	1.43	0.044	1.13
ln firmsize					
	t	−0.063***	−44.85	−0.063***	−45.03
	t-1	0.036***	31.89	0.034***	29.62
	t-2	0.007***	7.92	0.007***	7.84
ln education					
	t	0.032***	47.73	0.032***	48.01
	t-1	−0.021***	−35.72	−0.020***	−34.68
	t-2	−0.004***	−8.91	−0.004***	−8.60
wagelevel					
	t	−0.361***	−5.83	−0.357***	−5.78
	t-1	0.310***	5.11	0.320***	5.28
	t-2	0.034	0.55	0.026	0.42
Time Dummies		YES ***		YES ***	
Observations		679796		679796	
Groups		47291		47291	
AR(1)		−78.216***		−71.629***	
AR(2)		−0.870		0.299	
Sargan		916.114***		862.318***	

z-values based on heteroscedasticity consistent standard errors.
Levels of significance: *** 1 %, ** 5 %, * 10 %.

One other concern might be multicollinearity between the temporal lags of the explaining variables. While the stock values are of course quite stable, correlations between the differenced values are rather small (while the absolute value of no correlation coefficient is larger than 0.44, most lie between 0.1 and 0.2.).

Since the effects of the lagged variables should not be interpreted separately, at first only contemporaneous effects are described. Most of these coefficients are of a magnitude comparable to the ones of Blien/Südekum/Wolf (2006). The coefficient of the sector variable is to be interpreted as follows: An increase of employment growth by one percent in the whole industry increases growth in the single observation by 0.77 percent – keeping anything else constant. Strangely, the effect of employment growth in the whole region varies between model 1 and model 2. However, compared to the effect of the previous variable, the regional effect is very small. This could be cautiously interpreted as a contradiction of the importance of Jacobs externalities. An increase of employment growth in the whole region should increase agglomeration externalities that stem from urbanization and thus should have a positive effect on employment in the own industry. The strong positive effect of diversity in the short run draws a another picture. It implies that a stronger increase in diversity fosters employment growth. However, one has to be careful to interpret this as evidence for Jacobs externalities. These mostly take place in already diversified cities, where an even further increase in diversity is rather improbable compared to rural areas. For a clear interpretation, further checks are necessary. An increase in the growth of the share of small firms also has a negative effect, which contradicts the idea that, following McCann (2001), innovation primarily takes place in smaller firms. On the other hand, it supports the thesis that internal economies of scale have positive effects on growth. The education variable has the expected positive effect, which highlights the importance of human capital for employment growth. The wage growth has a negative effect on growth. This is plausible since one could argue that rising wages reduce the firms' profits and thus constrain growth.[29]

Table 4: Long run effects of dynamic panel data system estimation

	Model 1		Model 2	
	coeff.	z/$\chi^2(1)$-Value	coeff.	z/$\chi^2(1)$-Value
ln e	0.796^{***}	112.02	0.773^{***}	100.31
ln e * EG	0.003	0.71	—	
e * CI	—		0.042^{***}	7.71
ln sect	0.819^{***}	663.48	0.897^{***}	840.93
ln size	0.522^{***}	20.59	0.331^{***}	9.70
diversity	0.886^{***}	14.22	0.647^{***}	9.40
ln firmsize	-0.100^{***}	213.46	-0.098^{***}	251.90
ln education	0.036^{***}	104.76	0.037^{***}	131.00
wagelevel	-0.082	0.06	-0.049	0.02

Levels of significance: *** 1 %, ** 5 %, * 10 %.

[29] One might also argue that this variable could capture a productivity effect that increases wages and under certain conditions also employment. However, omitting this variable as well as instrumenting it with its lagged values has been tried but has no influence on the other coefficients.

Table 4 summarizes the long run effects of the explanatory variables of both models. For the lagged dependent and the interaction term, these were calculated by adding the lag coefficients. For the exogenous variables, the steady state effects were constructed by dividing the sum of all effects of one variable by the temporal multiplier: $\frac{\beta_{k,t}+\beta_{k,t-1}+\beta_{k,t-2}}{1-\alpha_{1,t-1}-\alpha_{1,t-2}}$.[30]

Turning to the coefficients of the lagged dependent variable and the interaction term, we find an effect of the lagged employment rate of approximately 0.8, which is about 10 percent smaller than what Blien/Südekum/Wolf (2006) found. Industries that are substantially localized according to the EG index do not exhibit stronger dynamic growth. This can be explained by the way how the EG index has been constructed: it varies only between industries but not between regions. Concentration of an industry as a whole does not create externalities for all of its establishments. Thus, proposition 2 cannot be confirmed in this analysis. Turning to model 2, we find a similar effect for dispersed industries but cells that are tagged as industrial agglomerations by the CI index show an additional dynamic growth effect of 0.042. Adding both effects still is significantly smaller than unity, so non-stationarity does not pose a problem in this model. We can argue that in industrial agglomerations, there are self reinforcing effects that lead to stronger dynamic employment growth. The sustainability of a former growth impulse is about 5.4 percent stronger than in non agglomerated regions. This means that shocks like the foundation of new establishments or extension of old ones are more persistent and have significantly higher long run effects on further employment growth. This confirms proposition 3, supporting the importance of MAR externalities.

In the long run, the sector effect keeps its magnitude, while the region size effect becomes considerably larger. An increase in the aggregate employment growth in a region's other industries obviously takes some time until it causes positive effects. Growth of diversity has a significantly positive effect on employment growth in the long run as well. This is evidence that at least in the long run an increase in size and diversification of a regional economy creates an environment that favors employment growth, which is some evidence that proposition 1 holds true.[31] While the effects of firmsize and education keep their significance and signs in the long run, the effect of the regional wagelevel becomes insignificant. It seems like wage growth might hinder employment growth in the short run but has no impact on the long run equilibrium.

6.2 Robustness Checks

To validate the robustness of the results, several checks have been carried out. First, both interaction terms have been plugged into the model simultaneously. The results of model 3 in table A.1 show that neither the short run coefficients nor the steady state effects change qualitatively. This confirms the intuition that there is no substantial multicollinearity between both interaction effects.

[30] Hence, the steady state effects only apply to observations with $\lambda = 0$. For the others, the steady state effects would be slightly larger: $\frac{\beta_{k,t}+\beta_{k,t-1}+\beta_{k,t-2}}{1-\alpha_{1,t-1}-\alpha_{1,t-2}-\alpha_{2,t-1}-\alpha_{2,t-2}}$.

[31] However, one has to keep in mind that it is not clear whether this result is caused by diversified cities or rural areas increasing their economic diversity. The next subsection shall bring some more insights on this matter.

Introducing their index, Ellison/Glaeser (1997) favor higher levels of regional aggregation. Their argument is that their index treats establishments in different regions equally, not taking into account the actual distance between these regions. This could pose a problem if co-location takes place in regional entities larger than NUTS-3 regions. To see if this influences the results, model 4 estimates the effects for a higher regional aggregation level. Instead of 326 districts, data have been aggregated to 112 labor market regions according to Eckey/Schwengler/Türck (2007). Since these regions have been defined according to commuting patterns, they should also present regions within which people are prepared to travel on a regular basis for other purposes than going to work. Thus most kinds of spillovers are unlikely to reach even further than beyond these regions' borders.[32] Indeed, there are some remarkable changes. The long run effect of the autoregressive term is somewhat larger than before. While the EG-interaction term is still not significant, the CI-interaction term has a much smaller long run effect. To explain this, one has to keep in mind that aggregating the observations to a higher regional scale means that the regions' economic structures become more similar. Consequently, some industrial agglomerations stay hidden and thus, MAR externalities are more difficult to measure. Another interesting result is the change in the effects of size and diversity. In the long run, the effect of employment growth in the whole region becomes much smaller and diversity is now barely significant. Both effects have been argued to measure Jacobs externalities, which are only effective in cities. Since labor market regions are not confined to cities but also their partly rural hinterland, these effects get blurred. The fact that their effect is reduced, when the difference between urban and rural regions is less pronounced, presents some evidence that $size$ and $diversity$ indeed captured Jabcobs-externalites in the previous models. Consequently, the lower level of aggregation seems to be the appropriate choice to measure agglomeration effects.

Finally, it is checked whether the results depend on the rather arbitrary choice of the thresholds for λ. Table A.2 displays results of the model with simultaneous interactions when thresholds are lowered (model 5) and raised (model 6). For the EG the new thresholds are 0.01 and 0.05 respectively, the latter being the value that indicates strong concentration according to Ellison/Glaeser (1997). For the CI, thresholds were chosen where all factors of this index are three times and five times as high as in the aggregate country, thus $3^3 = 27$ and $5^3 = 125$. The most remarking change is that the EG interaction effect becomes significant for the model with higher thresholds while the CI interaction effect decreases. In this case there might be some multicollinearity between both interaction terms since strongly concentrated industries are often confined to a small number of regions. The other coefficients show no qualitative changes.

[32] An alternative to this robustness check would be to explicitly model geographical relationships using spatial econometrics techniques. However, since the economic structure varies strongly between regions and in some cases even between years, it is very complicated to create a suitable weights matrix. To my knowledge, this has not been done for comparable data up to now.

7 Conclusions

Combining to strands of the existing literature on agglomeration effects, this paper provides some interesting new insights. While the positive effects of Jacobs externalities found in other works can be confirmed at least for the long run, there is evidence that previous works used models that were misspecified when trying to identify MAR externalities. Just considering the coefficients of former employment growth is not sufficient, since it does not distinguish between growth of localized and non localized observations. The finding that the effect of past on future employment growth depends on whether an industry/region cell is localized clearly presents evidence for the importance of MAR externalities. When employment in an industrial agglomeration grows, there is a high likelihood that growth will continue stronger than if the industry were not localized in this region. This speaks in favor of policies trying to support the emergence of clusters. However, whether regional policy can identify the proper industry to support and thus create initial growth in the first place, is questionable.

Further research on this topic could start with the measures of agglomeration. Instead of using dummy variables that indicate localization using arbitrary thresholds, one could use a continuous variable. Especially the localization index of Duranton/Overman (2005) is quite promising, because it cannot be influenced by the level of regional aggregation. However, this method needs detailed geographical information, which is not easily available. Another issue is that of spatial autocorrelation: since there might very well be spillovers between regions, they should not be treated as independent observations. Growth in one industry/region cell should be allowed to influence growth in contiguous ones. Spatial econometric methods for dynamic panel data are not yet state of the art, but are steadily becoming more applicable. Finally, further research should also consider to disentangle the causes of MAR externalities. Glaeser (2008) proposes to take into account different kinds of interrelations between industries and test which kind of them are most important to explain coagglomeration. Going one step further, using methods of spacial econometrics, “contiguous industries” could be allowed to have interrelationships which lead to common growth paths.

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Appendix

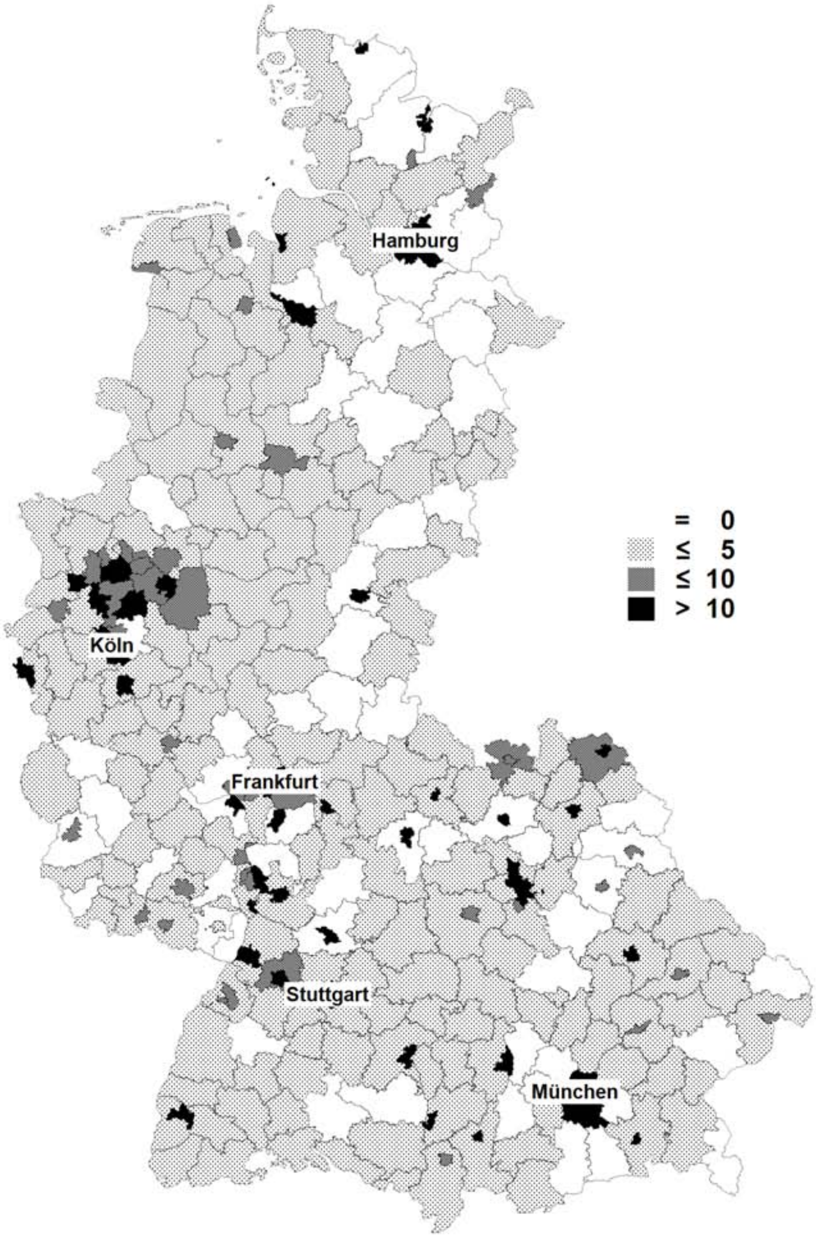

Figure A.1: Number of Industrial Agglomerations per Region in 2006

Table A.1: Robustness-Checks (I)

Dependent Variable: ln employment		Model 3 Simultaneous Interactions		Model 4 Regional Aggregation	
		coeff.	z/$\chi^2(1)$-Value	coeff.	z/$\chi^2(1)$-Value
ln e					
	long run	0.789***	108.15	0.810***	68.35
ln e * EG					
	long run	0.002	0.61	0.005	1.45
ln e * CI					
	long run	0.038***	7.21	0.023***	3.06
ln sect					
	contemp.	0.905***	38.64	0.530***	2.74
	long run	0.828***	736.67	0.996***	526.68
ln size					
	contemp.	0.064**	2.08	-0.022	-0.39
	long run	0.509***	23.61	0.430**	6.13
diversity					
	contemp.	0.395***	9.73	0.273***	3.77
	long run	0.819***	13.11	0.668*	2.56
ln firmsize					
	contemp.	-0.063***	-44.88	-0.059***	-26.02
	long run	-0.098***	221.38	-0.092***	55.15
ln education					
	contemp.	0.032***	47.75	0.029***	25.19
	long run	0.035***	105.42	0.032***	25.10
wagelevel					
	contemp.	-0.362***	-5.84	-0.569***	-4.78
	long run	-0.085	0.06	0.308*	0.25
Time Dummies		YES ***		YES ***	
Observations		679796		272870	
Groups		47291		18244	
AR(1)		-76.793***		-42.906***	
AR(2)		-0.532		-1.897*	
Sargan		1018.907***		426.815***	

z- and $\chi^2(1)$-values based on heteroscedasticity consistent standard errors.
Levels of significance: *** 1 %, ** 5 %, * 10 %.
Model 3 uses both interaction Terms of Model 1 and 2 from Table 3 simultaneously.
Model 4 uses regional data aggregated to 112 labor market regions instead of 326 districts.

Table A.2: Robustness-Checks (II)

Dependent Variable: ln employment		Model 5		Model 6	
		Lower thresholds for λ		Higher thresholds for λ	
		coeff.	z/$\chi^2(1)$-Value	coeff.	z/$\chi^2(1)$-Value
ln e					
	long run	0.778***	97.81	0.793***	110.96
ln e * EG					
	long run	0.003	1.33	0.008**	0.02
ln e * CI					
	long run	0.048***	9.66	0.038***	5.94
ln sect					
	contemp.	0.904***	39.02	0.897***	38.65
	long run	0.822***	976.42	0.779***	731.00
ln size					
	contemp.	0.060*	1.95	0.077**	2.53
	long run	0.371***	12.40	0.601***	31.96
diversity					
	contemp.	0.405***	9.85	0.418***	10.29
	long run	0.789***	13.42	1.077***	21.72
ln firmsize					
	contemp.	−0.063***	−44.78	−0.063***	−44.95
	long run	−0.093***	218.02	−0.102***	229.01
ln education					
	contemp.	0.032***	47.74	0.032***	47.83
	long run	0.035***	112.67	0.036***	107.23
wagelevel					
	contemp.	−0.346***	−5.46	−0.365***	−5.87
	long run	0.079	0.06	−0.164	0.23
Time Dummies		YES ***		YES ***	
Observations		679796		679796	
Groups		47291		47291	
AR(1)		−55.595***		−78.183***	
AR(2)		0.545		−0.635	
Sargan		1042.126***		1005.958***	

z- and $\chi^2(1)$-values based on heteroscedasticity consistent standard errors.
Levels of significance: *** 1 %, ** 5 %, * 10 %.
Model 5 uses thresholds of $EG > 0.01$ and $CI > 27$
Model 6 uses thresholds of $EG > 0.05$ and $CI > 125$

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